

# GUIDANCE NOTE 20

## INDIRECT DETERMINATION OF ENERGY INPUTS

### Problematic Energy Inputs

#### GN20.1

For some fuels it may be difficult to determine their energy inputs with the required accuracy set out in GN13.10. This may be because measurement of mass flow is unreliable or density and/or calorific values are variable. For example, biomass and solid, liquid and gaseous waste fuels will usually fall into this category. It may also be that the fuel is heterogeneous and contains fractions that have large particle sizes. In such cases the uncertainty associated with the fuel analysis and gross calorific value may be unacceptable because of the large errors associated with trying to obtain representative samples from site and in preparing representative sub-samples for laboratory analysis. These fuels may represent all or only a proportion of the CHP energy inputs. In such cases an indirect determination of the energy input may be considered. CHP Schemes that propose to use indirect methods to determine energy inputs should submit their proposals for approval.

### The Losses Method

#### GN20.2

When one of the energy inputs (or outputs) of an energy system cannot be measured with sufficient certainty, it may be possible to use the losses method to determine the missing quantity with a greater level of certainty. Essentially, the various heat losses and useful outputs are measured (or in some cases estimated); the losses are summed along with the useful outputs and the missing input component can be quantified from the compiled energy balance. The heat losses from a combustion system may include:

- Energy losses carried away in the flue gases (as sensible and latent heat)
- Chemical energy losses carried away in the flue gases (due to undeveloped heat of unburned gaseous fuel components)
- Losses in ash and dust as heat and unburned carbon (solid fuels)
- Mechanical and generation losses (for prime movers and driven machinery)
- Casing and cooling heat losses from the equipment
- Blowdown losses (for boilers)

#### GN20.3

The most important loss is the energy content of the flue gases. This can account for 15 to 40% of the fuel energy inputs on a gross calorific value basis. Determination of the flue gas losses requires analysis of the flue gas in terms of oxygen, carbon dioxide, carbon monoxide, hydrocarbons (or combustibles), sulphur dioxide and moisture, with the nitrogen content being calculated by difference. Also required is the flue gas temperature and the temperature and relative humidity of the combustion air. For direct calculation of the flue gas energy content, it is necessary to determine the mean flue gas velocity. Unless the flue sampling position is ideal, with an adequate number

of straight undisturbed duct lengths before and after the sampling position, then a sufficiently accurate determination of mean velocity can be very difficult. In some cases, a possible alternative may be to carry out a combustion calculation that avoids the need for velocity measurement.

However, as a minimum, sampling and determination of the fuel moisture content will be required together with analysis for ash, carbon, hydrogen and sulphur content. In addition, either the calorific value or the mass flow of the fuel or fuels needs to be measured. In other cases, this alternative approach will not be possible because of one or more of the difficulties highlighted in GN20.1.

#### **GN20.4**

Other losses may be relatively easy to determine or to make an appropriate allowance for, and in total will usually be no greater than 5%. To quantify the missing fuel input, the energy output as steam or hot water (boilers) or as power, (turbines or engines) must be metered. The heat in the feed-water (boilers) must also be measured and a complete energy balance constructed. If there are two fuel streams involved, then the energy input from one must be measured in order to calculate the other.

#### **GN20.5**

There are a number of British, other National, and International Standards that are applicable to the determination of energy balances and efficiency of combustion plant (e.g. BS 845 Parts 1 and 2:1987, ASME PTC4.4). However, it is likely that none of these will be ideal for the CHP Scheme under consideration. As these Standards are primarily designed for short-term performance testing over a period of a few hours, it will be necessary to adapt them to suit continuous monitoring of plant performance, using a holistic approach to determine the energy balance using all of the data that can reasonably be obtained.

## **ENERGY BALANCE MODELS**

#### **GN20.6**

It is possible to set up a calculation routine within EMS-type packages that will use measured variables to determine the unmeasured value of heat input.

This may be a realistic option for some CHP Schemes. Systems for checking the validity of the input variables may also be included. As yet there are no standards covering the setting up of these semi-continuous balances, but they will involve adaptations of the losses method.

#### **GN20.7**

Energy balance can be carried out by specialist companies. If this route is selected, details of procedures, data collected and an assessment of the resulting uncertainty in the calculated outcome should be provided with a Self- Assessment submission.

## UNCERTAINTIES

### GN20.8

An assessment of the uncertainty associated with derived energy inputs must be made. If this is in excess of  $\pm 2\%$ , the energy inputs shall be adjusted in accordance with the procedure set out in GN19 to determine the QI. See also GN12.12.

- Refer to GN18 for guidance on the determination of Uncertainty in Calculated Energy Inputs and Outputs.
- Refer to GN19 for guidance on Adjustment of Energy Inputs and Outputs for Excessive Uncertainty.